2023 COASTAL MASTER PLAN
COMMITTED TO OUR COAST

LOUISIANA POPULATION PROJECTIONS

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CPRA POPULATION PROJECTIONS

As a technical document of great importance to citizens of Louisiana and the nation, it is important that CPRA partners with experts to develop a clear, concise, and accurate information regarding the future of coastal Louisiana as part of the 2023 Coastal Master Plan.

To this end, CPRA intends to improve the treatment of population dynamics in the 2023 Coastal Master Plan.

These improvements may have important implications for understanding the challenges of a future without action condition and the benefit of implementation of the 2023 Coastal Master Plan.

The purpose of these projections is to provide an input for Risk Assessment modeling that is a part of the 2023 Coastal Master Plan.

OVERVIEW

OVERVIEW

POPULATION PROJECTIONS

- Population projections and Cohort-Change Ratios
- Error Evaluations
- Specifics for Louisiana

POPULATION PROJECTIONS AND COHORT-CHANGE RATIOS

COHORT-COMPONENT PROBLEMS

POPULATION PROJECTIONS

The Demographic Accounting Equation:

$$P_{t2} = P_{t1} + B_{t1\text{-}t2} - D_{t1\text{-}t2} + \text{In-}M_{t1\text{-}t2} - \text{Out-}M_{t1\text{-}t2}$$

Where: P_{t2} = the population projected at some future date

P_{t1} = the population at the base year t1

$B_{t1\text{-}t2}$ = the number of births that occur during the interval t1-t2

$D_{t1\text{-}t2}$ = the number of deaths that occur during the interval t1 - t2

$\text{In-}M_{t1\text{-}t2}$ = the amount of in migration that takes place during the interval t1 - t2

$\text{Out-}M_{t1\text{-}t2}$ = the amount of out migration that takes place during the interval t1 - t2

Cohort-component requires data on each component process disaggregated by the dimensionality of the population to be projected.

COHORT-COMPONENT PROBLEMS

POPULATION PROJECTIONS

- Incomplete data for all three components of change:
  - Gross migration data (in-migrants minus out-migrants) by age, sex, and race for all US counties, let alone subcounty units.
  - Birth data are suppressed by National Center for Health Statistics for <100k pop.
  - Death data are suppressed when there are fewer than 10 deaths at the county-level and are unavailable at the subcounty level.
- Birth/Death data are sometimes more available from state-level vital reporting agencies but are still usually unavailable at the subcounty level.

Missing these components make a traditional cohort-component implementation impossible in subcounty units.

COHORT CHANGE RATIOS

POPULATION PROJECTIONS

The Demographic Accounting Equation alternative:

Combine all components of change into a single “Change”

$$P_{t+1} = P_t + \left[B_t - D_t + M_{t,in} - M_{t,out}\right]$$

Possible to combine all components of change into a single “change” variable.

COHORT CHANGE RATIOS

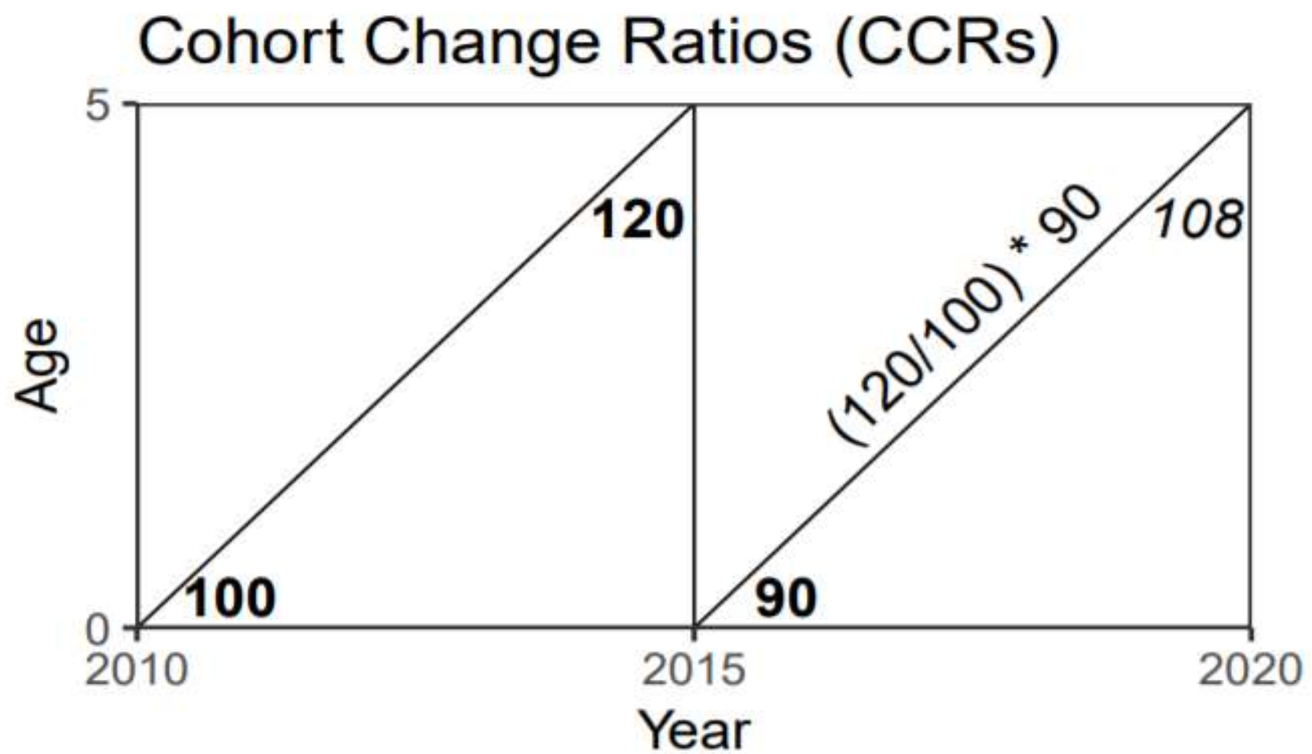
POPULATION PROJECTIONS

- Model all changes in the population together as the change in the population between two timesteps.

- Projection requires just population time series data rather than component data.

$$CCR_{x,t} = \frac{{}_nP_{x,t}}{{}_nP_{x-y,t-y}}$$

$${}_n\widehat{P}_{x,t+y} = CCR_{x,t} \cdot {}_nP_{x-y,t}$$



Lexis Diagram for Cohort-Change Ratios. The "observed" populations are in bold while the projected populations are italicized.

COHORT CHANGE RATIOS

POPULATION PROJECTIONS

- CCRs suffer from one major disadvantage over the use of cohort-component: Impossibly explosive growth in long-range projections due to the natural compounding of the ratios.

- Consider the growth presently occurring in McKenzie County, ND:
  - In 2010, McKenzie had a population of 6,360 that had ballooned to 12,792 by 2015, with a CCR for the 20-24 year old population of **2.46 (416 to 1,027)**. Implementing a 50-year population projection using that CCR would create a projected population that is approximately **8,000 times larger (2.46^{10})** – clearly an improbable number given the small, rural nature of its population.

- It's possible to have impossible over-projection when using CCRs.

COHORT CHANGE RATIOS

POPULATION PROJECTIONS

This problem of impossible over-projection has led to general “guidelines” surrounding CCRs.

1. Projection horizons should typically be small, typically 10- to 20-years.
2. Dimensionality should typically be limited due to the possibility of massive ratios (i.e., 2 -> 4 persons).

These problems can be better resolved using a slight change to the CCR formulation.

COHORT CHANGE RATIOS

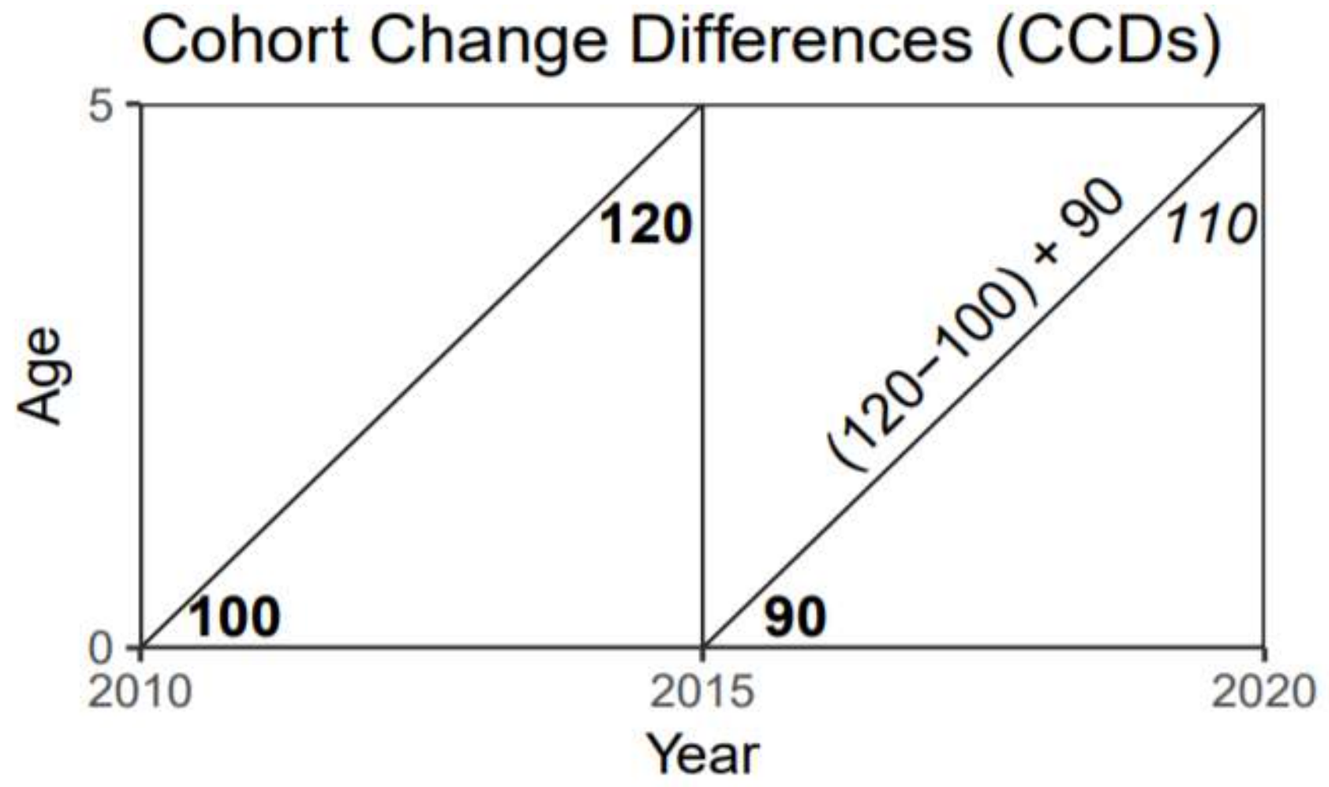
POPULATION PROJECTIONS

The implementation of CCRs naturally implies a multiplicative model.

However, it is possible to implement an additive model by using the difference in population rather than the ratio of population.

$$CCD_t = {}_nP_{x,t} - {}_nP_{x-y,t-y}$$

$${}_nP_{x+t} = CCD_t + {}_nP_{x-y,t}$$



Lexis Diagram for Cohort-Change Differences. The "observed" populations are in bold while the projected populations are italicized.

COHORT CHANGE RATIOS

POPULATION PROJECTIONS

CCDs are just as parsimonious as CCRs but have the additional advantage of producing *linear* growth rather than *exponential* growth.

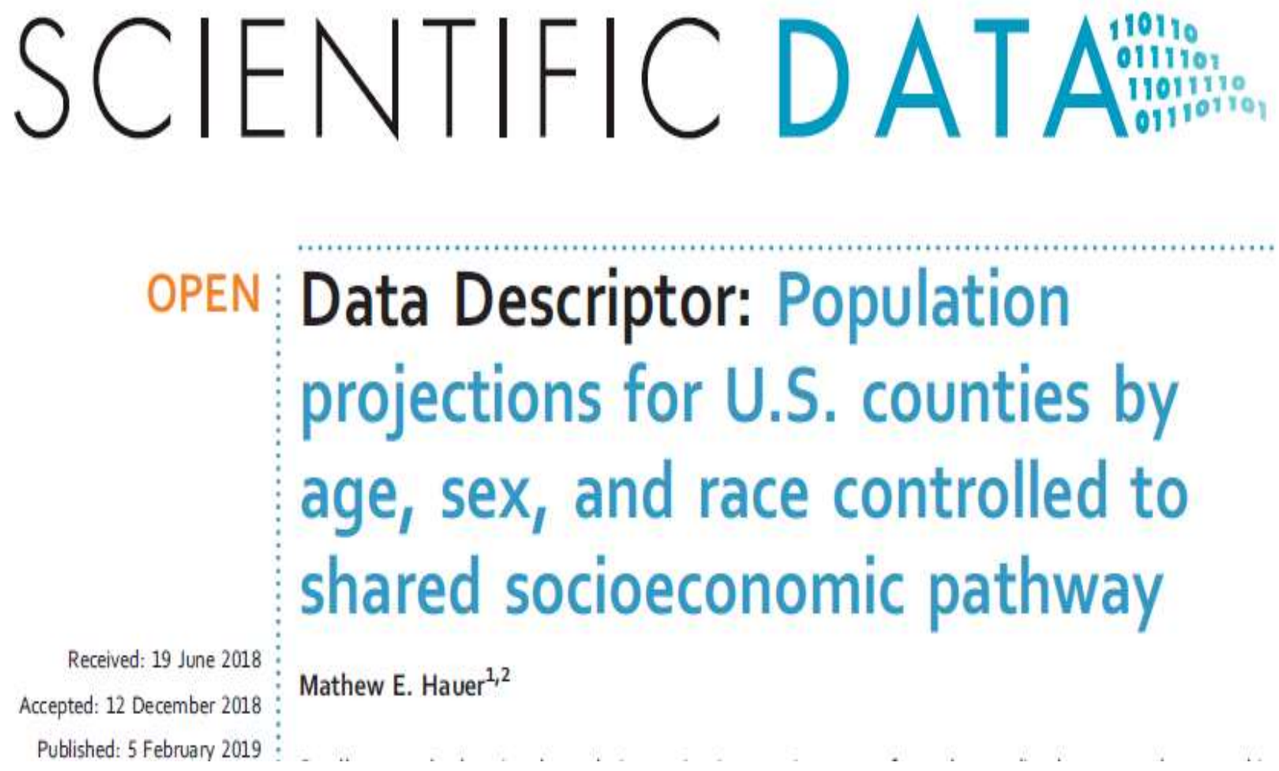
However, CCDs have the potential of creating impossible negative populations through linear decline.

A blended approach using CCDs in areas projected to grow and CCRs in areas projected to decline would rectify the possibility of negative populations.

SPECIAL CONSIDERATIONS FOR CCRs

POPULATION PROJECTIONS

- Group Quarters population
- Population aged 0-4 (since there is no preceding age group)
- Population aged 85+ (since there is no proceeding age group)
- For details on handling these populations, see:


SCIENTIFIC DATA

OPEN Data Descriptor: Population projections for U.S. counties by age, sex, and race controlled to shared socioeconomic pathway

Received: 19 June 2018
Accepted: 12 December 2018
Published: 5 February 2019

Mathew E. Hauer[1,2]

More info on this population projection approach can be found in the open source publication above.

ERROR EVALUATIONS

AGE, SEX, RACE JOINT ERRORS

ERROR EVALUATIONS

- Errors are evaluated for the period 2005-2015 based on the period 1970-2000.
- Median Symmetric Absolute Percent Error (SAPE).
- For all possible age/sex/race/county combinations.
- E.g., White Males aged 15-19 in Leon County, FL

Table 1: **Evaluation of Age/Sex/Race/County joint Errors.**

TYPE	num	EVAL	2005	2010	2015
CCD	336024	Median SAPE	6.3%	8.8%	11.6%
CCD/CCR	336024	Median SAPE	6.2%	8.6%	11.1%
CCR	336024	Median SAPE	6.4%	9.1%	12.8%

Source: Hauer, Mathew E. "Population projections for US counties by age, sex, and race controlled to shared socioeconomic pathway." *Scientific data 6* (2019): 190005.

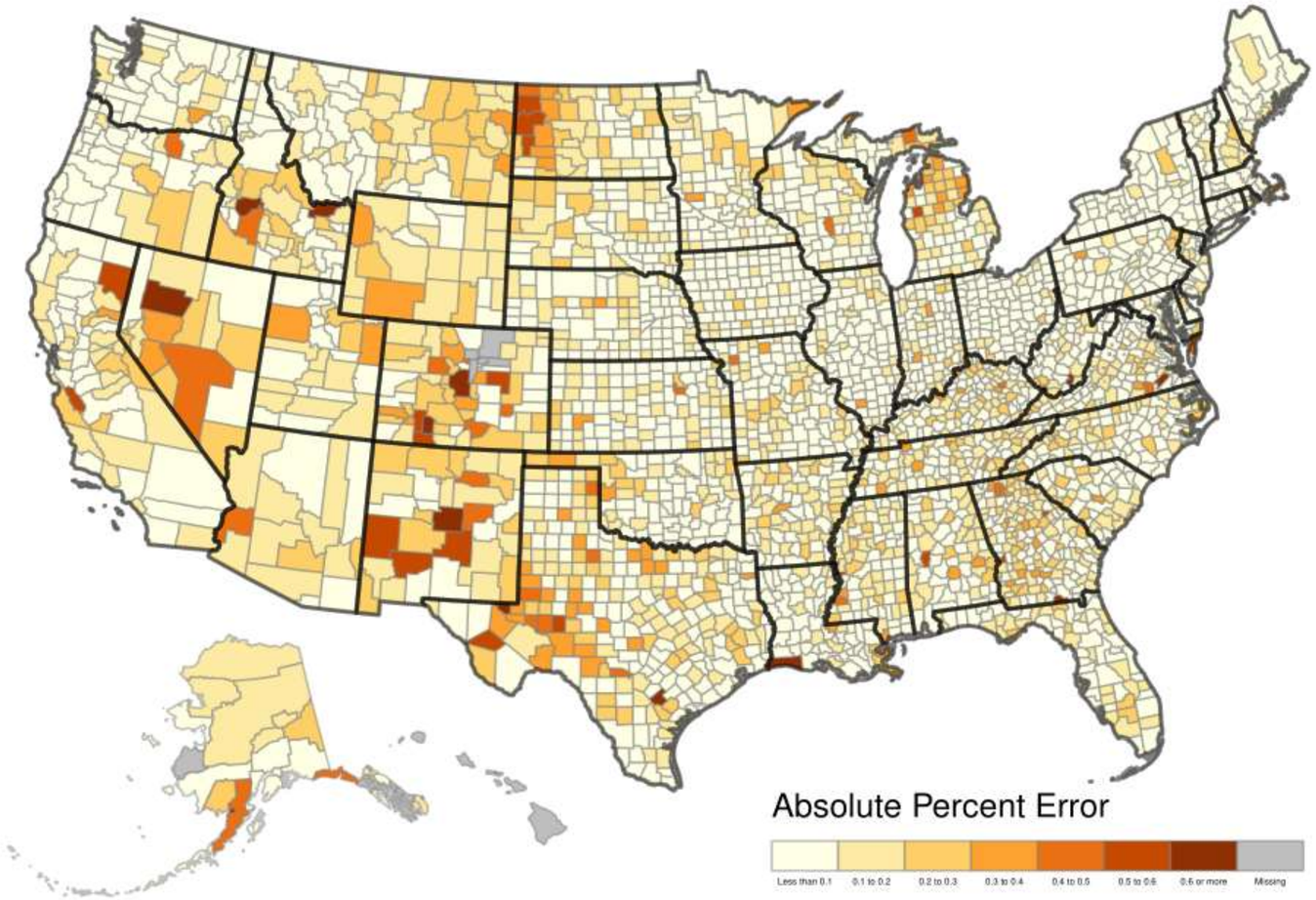
COUNTY-LEVEL TOTAL POPULATION ERRORS

ERROR EVALUATIONS

- Errors are evaluated for the period 2005-2015 based on the period 1970-2000.

- Notice most counties have less than a 20% error in their projected total population after 15 years.

- In Louisiana, only Cameron Parish exhibited a large error between 2000 and 2015.



Source: Hauer, Mathew E. "Population projections for US counties by age, sex, and race controlled to shared socioeconomic pathway." *Scientific data 6* (2019): 190005.

AGE STRUCTURE ERRORS

ERROR EVALUATIONS

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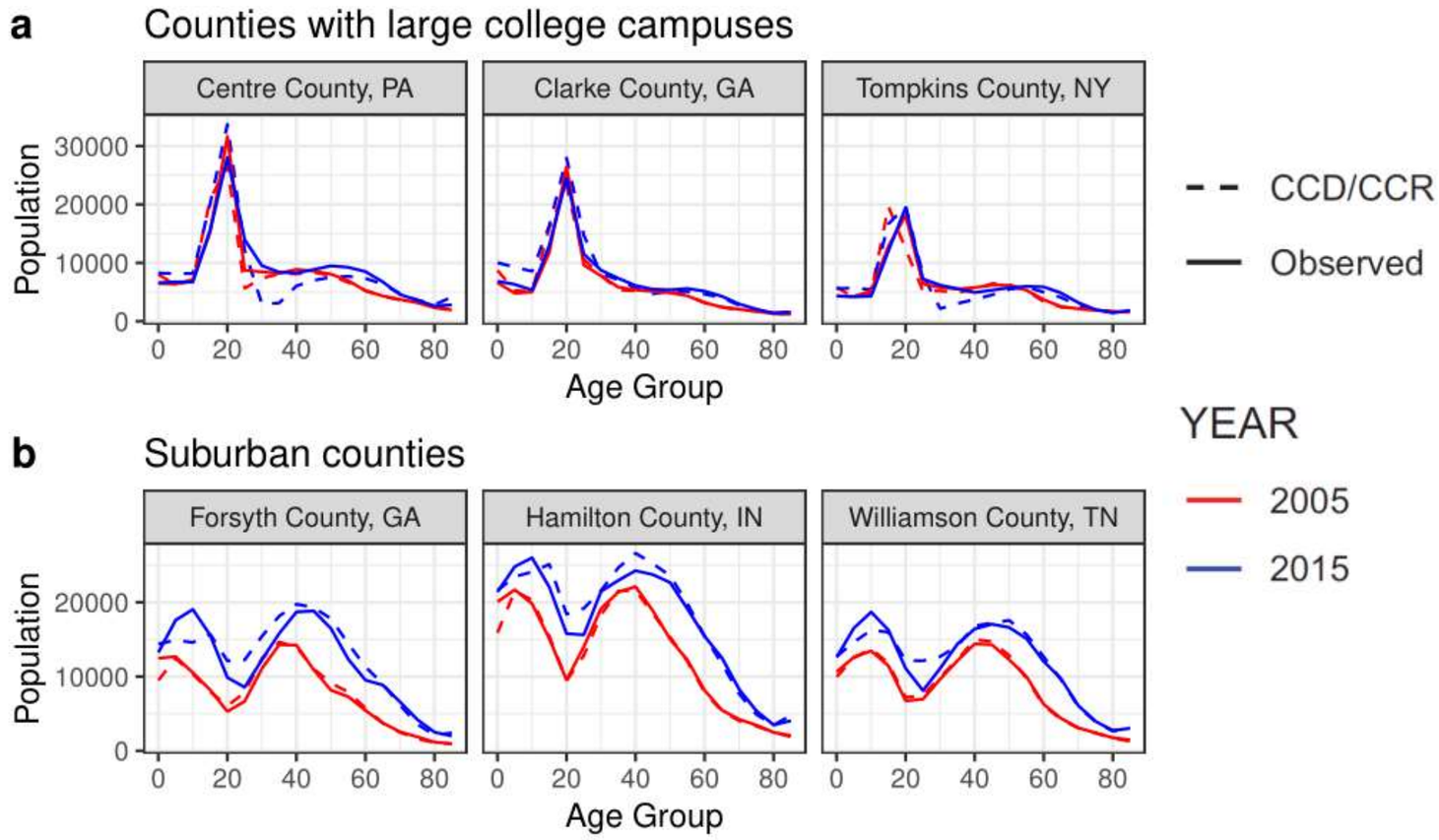
- Varying age-structures are importantly preserved with this approach.



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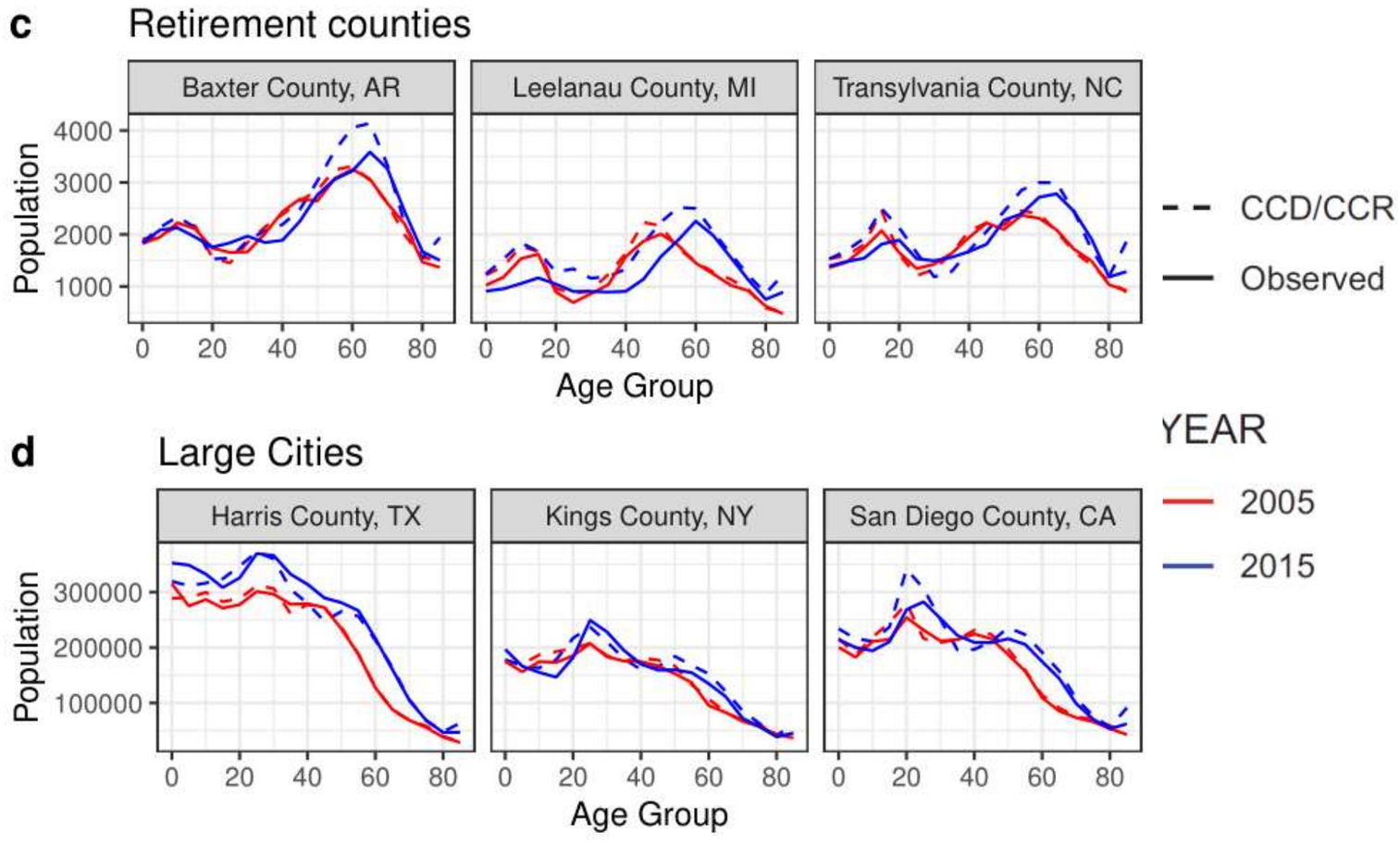


Source: Hauer, Mathew E. "Population projections for US counties by age, sex, and race controlled to shared socioeconomic pathway." *Scientific data 6* (2019): 190005.

ERRORS COMPARED TO OTHER POPULATION PROJECTIONS

ERROR EVALUATIONS

Errors are on par with or better than many cohort-component population projection models.

Author	Location	Methods	analysis	Metric	Projection Horizon	Errors
Wilson 2016	New South Wales	Ten cohort-component and CCR variants	Total population	Median APE	10-years	3.6% - 6.5%
Rayer 2008	US counties	Seven extrapolation approaches	Total population	Mean APE	10-years	9.3% - 13.7%
Smith & Tayman 2003	US counties	Cohort-component	Age Structure	Mean APE	10-years	6.7% - 10.6%
Smith & Tayman 2003	Florida counties	CCRs/Cohort-component	Age Structure	Mean APE	10-years	4.9% - 15.4%
Sprague 2012	US Counties	CCRs	Age structure	Mean APE	10-years	6% - 16%
Raftery et al 2012	Countries	Bayesian Cohort-Component	Total population	Mean APE	20-years	2.7%

Source: Hauer, Mathew E. "Population projections for US counties by age, sex, and race controlled to shared socioeconomic pathway." *Scientific data* 6 (2019): 190005.

…BUT WHAT ABOUT SUBCOUNTY?

ERROR EVALUATIONS

- The mutability of subcounty units (i.e., Tracts and Block Groups) make comparisons difficult.
  - The US Census Bureau redefines Tract and Block Group boundaries after each decennial Census, making most error evaluations apples-to-oranges comparisons.
- Baker, Swanson, and Tayman (2020) examined tract-level errors and found these errors are largely driven by extreme outliers in less than 1% of census tracts.
  - Thus, CCRs/CCDs are appropriate for small-area demographic projection.

SPECIFICS FOR LOUISIANA

LOUISIANA PROJECTIONS

SPECIFICS FOR LOUISIANA

Three main calculations:

1. The calculation of a ‘base’ population. All resident populations are projected
   - Populations at launch year are equal to the total population minus the group quarters (GQ) population and then GQ is added back in at time t+1.
   - The GQ data comes from the US Census and are ‘fit’ to the CBG based on (Total Population – Household Population) using iterative proportional fitting.
2. The calculation of CCRs/CCDs based on base-level input data.
   - The most straightforward calculation, outlined above.
3. The calculation of fertility rates.
   - These are projected at the state-level using an ARIMA(0,1,1) model based on the child-woman ratio. All CBGs use the state-level fertility rate.

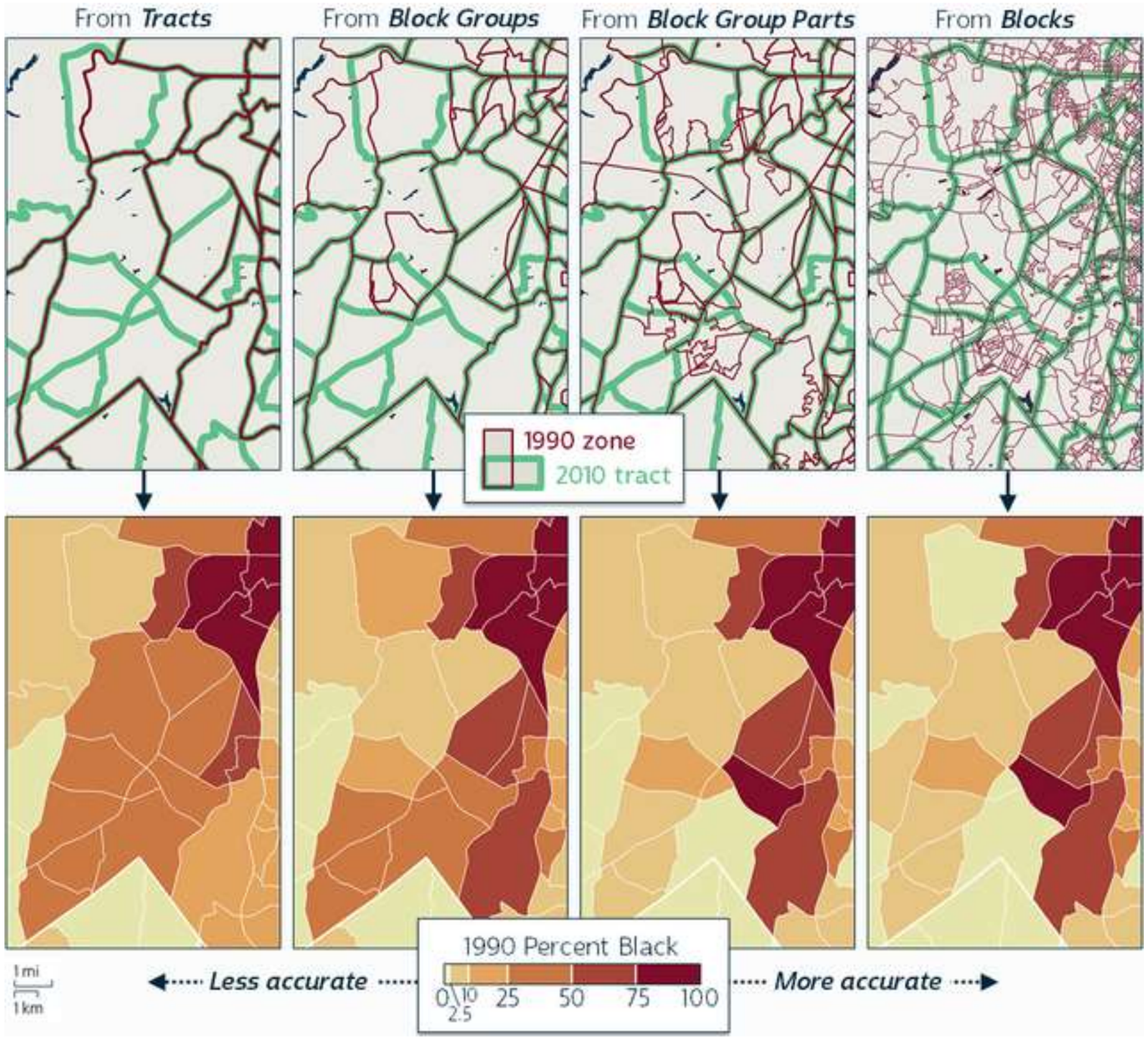
LOUISIANA PROJECTIONS

SPECIFICS FOR LOUISIANA

- Data comes from the National Historic Geographic Information System (NHGIS) published by IPUMS at U of Minnesota.

- These data are standardized Block Group boundaries for the period 1990-2010.

- All calculations are based on this time series:
  - “Launch Population” in 2010
  - CCRs/CCDs
  - Fertility Rates

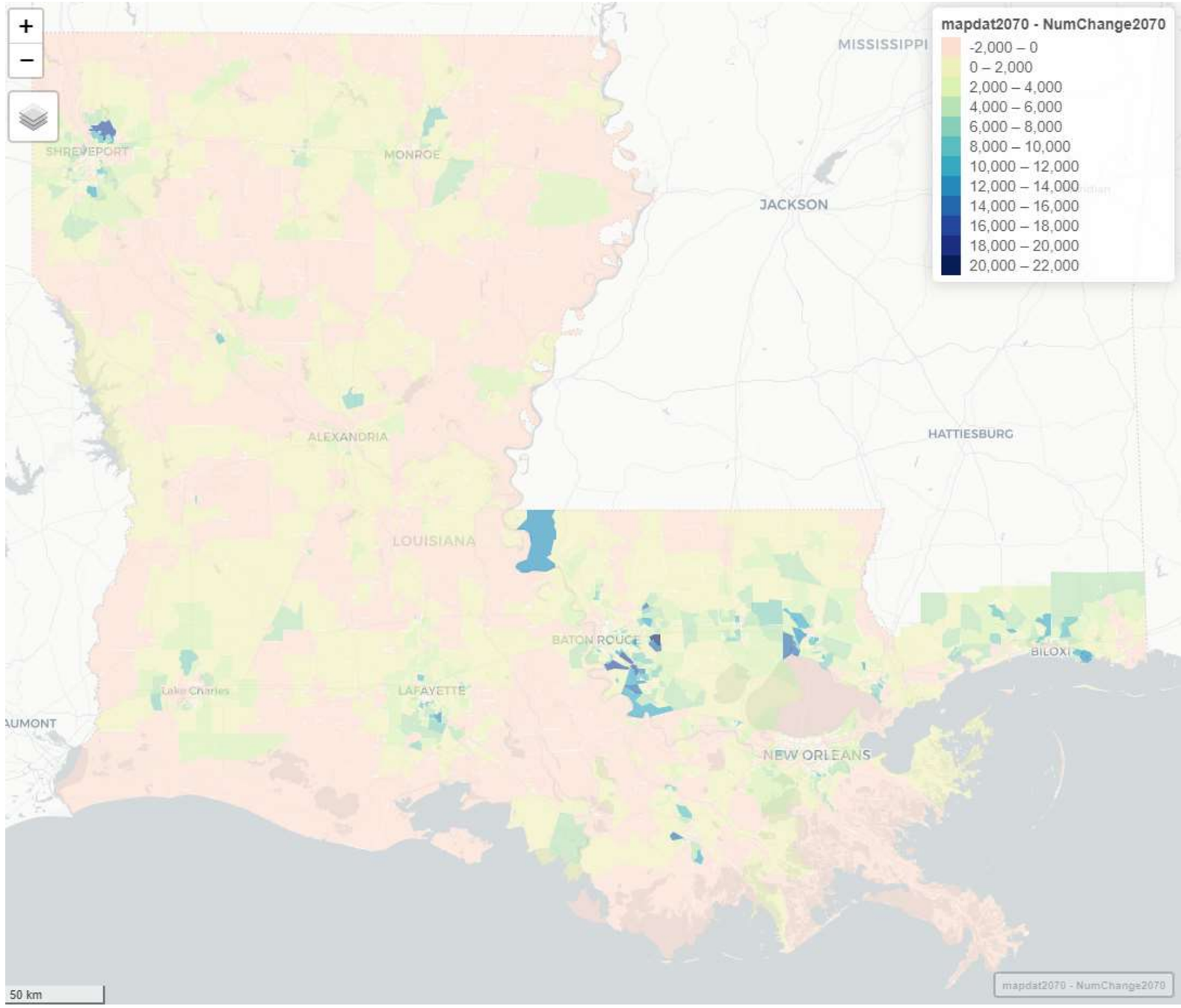


Source: National Historic Geographic Information System.

LOUISIANA PROJECTIONS

SPECIFICS FOR LOUISIANA

- Numeric change for Census Block Groups in Louisiana for the period 2020-2070.
- Many block groups are projected to decline between 0 and 2,000 persons over the next 50 years.
- Many of the fastest growing areas are suburban Shreveport, Baton Rouge, and Lafayette.
- Largest population increase is 22,000 persons just outside Baton Rouge.



LOUISIANA PROJECTIONS

SPECIFICS FOR LOUISIANA

These projections, like all projections, involve the use of certain assumptions about future events that may or may not occur. Users of these projections should be aware that although the projections have been prepared with the use of standard methodologies and with extensive attempts being made to account for existing demographic patterns, they may not accurately project the future resident population of Louisiana.

The projections are based on historical trends and current estimates. These projections should be used only with full awareness of the inherent limitations of population projections in general and with knowledge of the procedures and assumptions described in the final deliverable Methodology document.

Thanks!

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